Postdisaster PTSD Over Four Waves of a Panel Study of Mexico's 1999 Flood

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Samples of adults representative of Tezuitlán, Puebla and Villahermosa, Tobasco (combined $N = 561$), were interviewed 6, 12, 18, and 24 months after the devastating 1999 floods and mudslides in Mexico. Current *DSM-IV* PTSD and major depressive disorder (MDD) were assessed with the Composite International Diagnostic Interview. At Wave 1, PTSD was highly prevalent (24% combined), especially in Tezuitlán (46%), which had experienced mass casualties and displacement. Both linear and quadratic effects of time emerged, as PTSD symptoms initially declined but subsequently stabilized. Differences between cities lessened as time passed. Comorbidity between PTSD and MDD was substantial. The findings demonstrate that the international health community needs to be prepared for epidemics of PTSD when disasters strike developing areas of the world.

KEY WORDS: disaster; PTSD; depression; Mexico; longitudinal studies.

A substantial literature on the effects of disasters has accumulated over the past 25 years. These studies allow several tentative conclusions to be reached about the nature of these effects. First, it appears that posttraumatic stress disorder (PTSD) is among the most common adverse consequences for which disaster victims are at risk. Norris et al. (2002) found evidence of PTSD in 109 (68%) of 160 samples that were included in their review. Symptoms of PTSD typically begin soon after the event (e.g., North, Smith, & Spitznagel, 1997; Waelde, Koopman, Rierdan, & Spiegel, 2001) and may persist for years after disasters that are especially severe (e.g., Green et al., 1990; Yule, Bolton, Udwin, O'Ryan, & Nurrish, 2000). Depression is also common in the aftermath of disaster, often occurring in combination with PTSD (e.g., Bolton, O'Ryan, Udwin, Boyle, & Yule, 2000; de la Fuente, 1990; Fullerton, Ursano, Tzu-Cheg, & Bhartiya, 1999; Lima, Pai, Santacruz, & Lozano, 1991; McFarlane & Papay,

1992; Norris, Perilla, Riad, Kaniasty, & Lavizzo, 1999).

A second tentative conclusion that can be derived from the research base is that disaster victims' symptoms tend to improve over time. However, in studies with three or more assessment points, downward trends only occasionally have been found to be simply linear in form (e.g., La Greca, Silverman, Vernberg, & Prinstein, 1996). Sometimes symptoms declined at first and then stabilized (e.g., Bromet, Parkinson, & Dunn, 1990; Carr et al., 1997; McFarlane, 1989) or even showed a quadratic or cyclical pattern wherein symptoms peaked at the second wave of data collection (Phifer & Norris, 1989). Given that studies with three or more postdisaster assessments are few in number and often have not included measures of PTSD, the natural course of postdisaster PTSD is not yet well understood.

A third tentative conclusion that can be derived from the research base is that natural disasters are especially problematic when they occur in the developing world, which includes but is not limited to Latin America (e.g., Caldera, Palma, Penayo, & Kullgren, 2001; Canino, Bravo, Rubio-Stipec, & Woodbury, 1990; de la Fuente, 1990; Durkin, 1993; Goenjian et al., 2001; Lima et al., 1990,

1991). Disaster location (United States, other developed country, developing country) was a stronger predictor of sample-level impact than either disaster type (mass violence, natural, technological) or sample type (child, adult, rescue/recovery) in Norris et al.'s (2002) review. Yet, studies of disasters in developing countries compose only a small fraction (14%) of published studies and, when desirable study characteristics, such as representative samples, standardized measures, and longitudinal designs, are taken into account, the numbers become exceedingly few.

Fewer conclusions can be reached about the specific aspects of disasters that make one more stressful than another. In recent years, much of the attention in the field has been directed at mass violence, i.e., at terrorism and other intentional human-caused events, such as shooting sprees. This concern is valid as data on these events are few but nonetheless suggest that survivors of mass violence are at higher risk for PTSD than survivors of natural or technological disasters (Norris et al., 2002). Wrongly, such concerns are often overgeneralized to imply that natural disasters have minimal trauma potential. Natural disasters come in a myriad of forms and severity levels. Findings regarding the relative or comparative impact of specific stressors that occur as a result of natural disasters, such as injury, threat to life, bereavement, loss, and relocation, have been inconsistent, perhaps because correlations between such variables are often high, and effects are influenced by the relative frequencies of the various stressors. Nonetheless, especially when the outcome of concern is PTSD, it is reasonable to anticipate that natural disasters involving sudden onset, mass casualties, and high trauma exposure are likely to be more pathogenic than natural disasters characterized primarily by property damage and loss.

The present study examined the stability of PTSD symptoms over four waves of a panel study conducted after the Mexican flood of 1999. In October 1999, a stationary tropical depression in the Gulf of Campeche generated torrential rains, widespread flooding, and devastating mudslides in nine Mexican states. More than 400 people died, and at least 200,000 people lost their homes. Officials in Mexico characterized this event as the worst flooding disaster of the decade, if not of the century (Red Cross, 1999). To capture the variability in the way this event was experienced, we studied two different communities: Villahermosa, the capital of the coastal state of Tobasco, population 500,000, and Tezuitlán, a mountain city in the state of Puebla, population 180,000. These communities anchor the geographic range of the disaster. The extent and duration of the flooding were actually worse in Villahermosa, but the sudden and unexpected mudslides

in Tezuitlán caused dramatic losses, bereavement, and trauma.

We hypothesized, first, that the Mexican floods of 1999 would generate a high prevalence of PTSD at 6 months postevent. To be consistent with Norris et al.'s (2002) review, "high prevalence" was operationalized as a current PTSD prevalence of approximately 25% or higher. Second, we hypothesized that the prevalence of PTSD would be significantly higher in Tezuitlán than in Villahermosa because of differences in the ways the event was experienced in these 2 communities. Third, we hypothesized that PTSD symptoms would decline over the course of the study but that the function would not be simply linear. We anticipated that an initial decline (between 6 and 12 months) would be followed by a stabilization of symptom levels. Even at 2 years, the prevalence of current PTSD was expected to exceed normative levels for Mexico. By the end of the study (at 2 years postevent), these trends were expected to have lessened the differences between the two studied communities but not to have eliminated them. Finally, we expected to find comorbid major depressive disorder (MDD) at each wave of the study.

As is recommended for investigations in non-Western or developing countries, we conducted a considerable amount of preliminary research on PTSD in Mexico before undertaking the present study. In an initial qualitative study (Norris, Weisshaar, et al., 2001), survivors of various disasters in Mexico were asked to describe their emotional reactions in unstructured interviews. Of the 17 criterion symptoms for PTSD, 14 were mentioned with little or no prompting by study participants. The participants also provided an abundance of expressions (e.g., remain affected, always live with the fear, ill from fright [susto], stayed more traumatized) that could not be classified as specific criterion symptoms but clearly implied that the concept of trauma, more globally defined, was a meaningful one. Depression also emerged as an important cluster. A subsequent quantitative, comparative study was conducted with samples of disaster victims from the United States (Hurricane Andrew, non-Hispanic participants only) and Mexico (Hurricane Paulina). A four-factor measurement model, specified a priori to represent the accepted multicriterion conceptualization of PTSD, fit the data of the United States and Mexican samples equally well (Norris, Perilla, & Murphy, 2001). A subsequent epidemiologic study of trauma and PTSD in four cities provided evidence that trauma is approximately as common in Mexico as it is in the United States but that lifetime rates of PTSD are somewhat higher (Norris et al., 2003). Altogether, the evidence from these preliminary studies established that PTSD is relevant for, and measurable in, Mexican trauma survivors.

Methods

Sampling and Interviewing Procedures

Visits to the two selected communities revealed that identical sampling procedures would not be possible. In Villahermosa, the flood damage was extensive, and victims were dispersed across a large sector of the city. The context necessitated a probability sampling design to draw a sample of adults representative of the afflicted population. In Tezuitlán, the stricken hillside communities were condemned, and all families were relocated to a new community outside of the original city. The size of the community did not necessitate sampling, and all households were included in the sampling frame. Despite the difference in approach, both strategies provided samples that were highly representative of the populations and settings.

The initial interviews were conducted 6 months postdisaster, in April 2000. From affected census tracts in Villahermosa, 653 households were sampled randomly in proportion to the tracts' population sizes. Of the 601 eligible households (noneligible units were vacant lots or businesses), 530 were successfully contacted and the adult who answered the door was asked to provide a sociodemographic interview about the household. Of these households, 470 agreed to complete this initial interview. One adult resident was then randomly selected from each participating household and asked to participate in an in-depth psychological interview. Of these, 461 completed the psychological interview, for a final Wave 1 response rate of 77% of those assessed as eligible and 87% of those actually contacted. In Villahermosa, 318 or 69% of the Wave 1 participants were women.

In Tezuitlán, all 235 households provided with plots in the new community were selected and, of these, 209 were successfully contacted. Only one household refused the demographic interview. Of the 208 households that completed the demographic interview, 205 participants completed the psychological interview, for a final response rate of 87% of those eligible and 98% of those actually contacted. In Tezuitlán, 133 (65%) of the 205 participants were women. The proportion of women did not differ between the two cities, $\chi^2(1, N = 666) = 1.08, p = .30$.

Attempts were made to reinterview all participants at points 12, 18, and 24 months postdisaster. In Villahermosa, 385 or 84% of the participants completed all four psychological interviews, as did 176 or 86% of the participants in Tezuitlán. The proportions of women, 69% in Villahermosa and 67% in Tezuitlán, did not change over time.

The proportion of women in the sample was higher than it should have been (55%) according to the most recent Mexican census data. Analyses of the sociodemographic data indicated that the bias occurred at the point of selection for the psychological interview, although the reason for this was not clear. This selection was made at the end of the demographic interview, well after the informant had provided the birthdays, birth years, and present residence status of each household member. Fieldwork supervisors reviewed audiotapes of each interview and verified that the interviewer selected the appropriate adult (the one with the most recent birthday) for the psychological interview regardless of who gave the sociodemographic interview or who was home at the time of that initial interview. Analyses of the household demographic data indicated that female participants were quite representative of the larger population of women, but male participants underrepresented younger, lower-income, less-educated men (who are perhaps less residentially stable). With effect sizes (d) in the range of .09–.12, the magnitude of the bias appeared to be relatively small. To derive an unbiased population estimate, weights were applied to correct the sex distribution to a 55:45 ratio of women to men in each city. These weights were 1.466 for Villahermosa men, 0.794 for Villahermosa women, 1.339 for Tezuitlán men, and 0.829 for Tezuitlán women.

All interviews were completed by trained, local interviewers in respondents' homes in private. The demographic interviews lasted about 1 hr, and psychological interviews lasted an average of 2 hr. Demographic and psychological interviews were typically completed on separate days. Fieldwork managers later revisited each participating household to deliver a letter of thanks and to ask the respondent for his or her impressions of the interview and interviewer. Study procedures were approved by institutional review boards in the United States and Mexico and were reviewed for adherence to federal (US) guidelines for conducting research in international settings.

Measures

Exposure to the flood and landslides was assessed by four primary questions that asked about (1) whether respondents had experienced the death of a friend or family member (traumatic bereavement); (2) whether they or other surviving members of the household were injured or had experienced an illness as a direct consequence of the flood (injury to self or a household member); (3) whether they felt that they were in danger of losing their lives during the event (life threat); and (4) whether their dwellings were damaged by the landslides or floods to an extent perceived as much or enormous (property damage). These variables were coded as 1 (exposed) or 0 (unexposed); the experiences were not mutually exclusive.

Current (past 6-month) PTSD was measured by using a modified version of Module K of Version 2.1 of the Composite International Diagnostic Interview (CIDI), developed and translated into Spanish by the World Health Organization (1997). The CIDI has been used widely in prior epidemiologic studies, including a four-city study in Mexico (Norris et al., 2003). The CIDI assesses all *DSM-IV* criteria for PTSD (American Psychiatric Association, 1994) as they emerge after a specified event. To measure current disaster-related PTSD at each wave, the questions referred to symptoms attributed to the flood and experienced within the past 6 months. A count of affirmative responses to CIDI symptom questions (range 0–17) provided a continuous measure of PTSD symptoms, $\alpha = .89$.

The module that assessed disaster-specific PTSD was located early in the interview protocol. The original CIDI Module K was included later in the protocol to assess lifetime trauma exposure and PTSD for events other than the 1999 flood.

To our knowledge no studies have documented the clinical validity of the Spanish version of the CIDI PTSD module. However, Breslau, Kessler, and Peterson (1998) found good agreement between the English version of the same module and clinicians' evaluations (sensitivity = 95%; specificity = 71%; $\kappa = .63$). Norris, Perilla, and Murphy (2001) reported a correlation of .80 between Spanish versions of the CIDI symptom count and the Revised Civilian Mississippi Scale for PTSD (RCMS). This high agreement is meaningful because both the linguistic equivalence (Norris & Perilla, 1996) and conceptual equivalence (Norris, Perilla, & Murphy, 2001) have been established between English and Spanish versions of the RCMS.

Module E of the CIDI was used to measure MDD. The MDD module has been used previously with both Mexicans and Mexican Americans (Vega et al., 1998). At Wave 1, we assessed both lifetime and current (past 6-month) MDD. At subsequent waves, only current MDD was assessed.

Results

Analyses presented here were conducted on the four-wave, weighted sample ($n = 561$). Participants in the two cities were of comparable age, averaging 37 years in Villahermosa ($SD = 13$) and 38 years in Tezuitlán ($SD = 14$), $t(559) = 1.04$, $p = ns$. However, having 9 years of education, on average ($SD = 5$), participants in Villahermosa were more highly educated than participants in Tezuitlán who averaged only 6 years of education ($SD = 4$), $t(559) = 7.50$, $p < .001$. Thus education was included as a covariate in the hypothesis tests.

Table 1. Trauma Exposure and Outcomes (%) at Wave 1 in Villahermosa and Tezuitlán

Variable	Villahermosa ($n = 385$)	Tezuitlán ($n = 176$)	$\chi^2(1)$
Disaster-related bereavement	13.1	60.2	127.85***
Disaster-related injury, household	70.1	44.3	33.68***
Disaster-related life threat	68.8	73.3	1.15
Much/enormous property damage	43.3	59.1	12.08***
Met criterion A2 for disaster	71.2	95.5	52.22***
Met criterion B for disaster	81.8	98.3	38.33***
Met criterion C for disaster	33.2	68.8	62.35***
Met criterion D for disaster	57.4	93.8	88.82***
Met all symptom criteria for disaster	28.1	67.6	78.56***
Met criterion E for disaster	36.1	71.0	60.29***
Met criterion F for disaster	59.0	83.5	35.36***
Disaster-related PTSD	13.8	46.0	65.42***
Other trauma, lifetime	72.5	84.1	9.47**
PTSD, other cause, lifetime	12.2	26.1	16.00***
Current PTSD, other cause	3.9	9.1	5.79*
Current PTSD, all causes	15.8	50.6	70.96***
First-time PTSD from disaster	10.4	31.3	34.87***
Postdisaster MDD	6.5	14.8	9.34**
First-time MDD after disaster	2.1	4.5	2.47
Predisaster MDD, lifetime	13.0	15.9	0.85

$^*p < .05.\ ^{**}p < .01.\ ^{***}p < .001.$

Descriptive Statistics for Wave 1

Table 1 provides descriptive data about the nature of the two communities' exposure. As expected, victims in Tezuitlán were far more likely than victims in Villahermosa to have been bereaved, and they were somewhat more likely to have experienced much or enormous property damage. Contrary to our expectations, however, victims in Villahermosa were actually more likely than victims in Tezuitlán to have been injured (including experiencing physical illness that was directly attributable to the flood), and the two groups were equally likely to have experienced life threat. Apparently, we had underappreciated the severity of the storms (i.e., from the tropical depression) that initiated the flooding. Moreover, many of the survivors in Tezuitlán had not been home at the time the hillsides collapsed, and a few were relocated because of the condemnation of their neighborhoods rather than because of destruction of their homes. Correlational data substantiated this, as in Tezuitlán, bereavement was uncorrelated with either life threat ($r = -.04$) or injury ($r = -.02$). Summing the four primary stressors indicated that Tezuitlán victims were, overall, more highly exposed. They averaged 2.4 on this count, compared to 1.9 in Villahermosa, $t(559) = 4.47$, $p < .001$. Moreover, it should be recalled that all Tezuitlán victims had been relocated, whereas only 3% of Villahermosa victims moved.

Table 1 also shows the data on PTSD at Wave 1, 6 months postevent. Consistent with the data on exposure, Tezuitlán victims were more likely to meet criterion A2 regarding the disaster than were Villahermosa victims. That is, terror, horror, and helplessness were common in the latter but nearly universal in the former. Likewise, Tezuitlán victims were more likely than Villahermosa victims to meet criteria B (1 + intrusion symptom), C (3+ avoidance/numbing symptoms), and D (2+ arousal symptoms). Across symptom criteria, Tezuitlán victims averaged 11 symptoms ($SD = 4$), whereas Villahermosa victims averaged 6 ($SD = 5$), t (559) = 11.97, $p < .001$. Altogether, 46% of Tezuitlán victims met all DSM-IV criteria for PTSD, which was more than three times higher than the prevalence of 14% in Villahermosa. Together, 24% of study participants met DSM-IV criteria for disaster-specific PTSD at Wave 1.

Interpretation of these results was complicated by finding that Tezuitlán participants had also been more likely than Villahermosa participants to experience other potentially traumatic events over the course of their lives and to have met criteria for PTSD for the one event they considered their worst (see Table 1). Nine percent were still suffering from this other trauma in Tezuitlán, compared to 4% in Villahermosa. Both cities' prevalences of current PTSD (past 6 months) exceed that observed in the general population in Mexico (approximately 2%[4]). These findings raise questions about the ability of respondents to make accurate attributions regarding the source of their distress, an issue that sparks controversy in PTSD assessment. Although our methodology does not allow a clear resolution of this dilemma, the most conservative estimate of the differential effects of the disaster is derived by considering only new (first-time) cases of PTSD. On the basis of this estimate, disaster-specific PTSD was substantially less prevalent in Tezuitlan (31%) and Villahermosa (10%) but the 3:1 ratio was retained. Altogether, the evidence that PTSD was dramatically more prevalent in Tezuitlán appears irrefutable.

As Table 1 shows, the two cities also differed in the prevalence of postdisaster MDD. In Tezuitlán, the prevalence of MDD within the past 6 months was 14.8%, (95% CI = 9.4–20.2), which is substantially above the normative 6-month rate for Mexico (6.3%[5]), but in Villahermosa, the prevalence of MDD in the past 6 months (6.5%) was equivalent to the normative 6-month rate. Approximately

one third of the cases of postdisaster depression were new (first-time) cases. For Mexico generally, the incidence of MDD for a 6-month period is 1.6%.[6] Because standard errors are large for city-specific samples, this value falls within the 95% confidence interval for the incidence of MDD in Tezuitlán (1.4–7.6%) as well as in Villahermosa (0.7–3.5%).

Considered together, 28% of the combined sample met criteria for either PTSD or MDD at Wave 1. By city, these percentages were 18% in Villahermosa and 51% in Tezuitlán, $\chi^2(1, N = 561) = 64$ .12, $p < .001$.

Longitudinal Analysis of PTSD Prevalence

Figure 1 shows the course of DSM-IV PTSD over time for the combined sample and each city separately. The two cities differed significantly at each wave, although the magnitude of the difference declined over time. Values for $\chi^2(1, N = 561)$ were 65.42, $p < .001$, at Wave 1; 37.95, $p < .001$, at Wave 2; 27.97, $p < .001$, at Wave 3; and 13.57, $p < .001$, at Wave 4.

The confidence intervals are shown in Fig. 1 as well as the point estimates to facilitate comparisons over time. For the sample as a whole, the data suggest the presence of both linear and quadratic trends in PTSD, in which the prevalence first declines, then stabilizes. The upper bound of the estimate at Wave 2 overlaps minimally with the lower bound of the estimate at Wave 1, and the lower bound of the Wave 2 estimate overlaps minimally with the upper bound of the estimate at Wave 3. The upper bound of the estimate at Wave 3 is well below the lower bound of estimate at Wave 1. The estimates and confidence intervals are nearly identical for Waves 3 and 4.

The trends described for the total sample also describe Tezuitlán very well. The data are quite different for Villahermosa. Although the upper bound of the estimate at Wave 3 is below the lower bound of the estimate at Wave 1, otherwise the confidence intervals overlap. Overall, the prevalence of PTSD is lower but more stable in Villahermosa than in Tezuitlán.

Longitudinal Analysis of PTSD Symptoms

For testing hypotheses regarding trends, we used the continuous measure, the symptom count, rather than diagnosis because it was better suited for such tests. Dichotomous variables have limited power to detect change. For example, among respondents who met criteria for PTSD
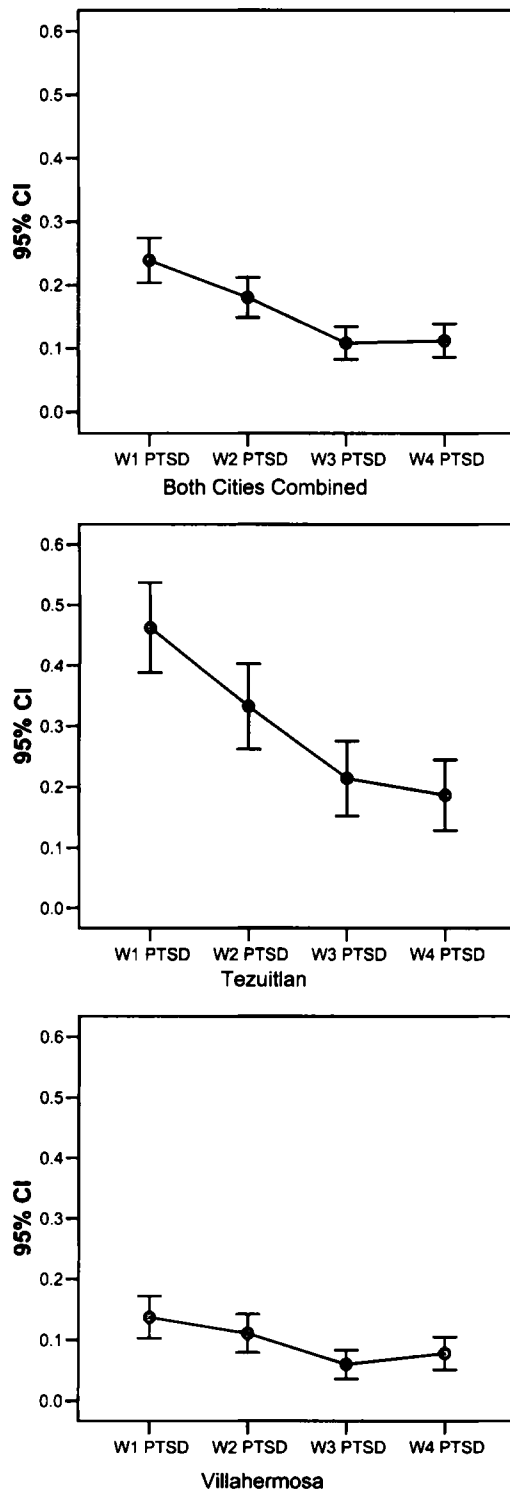
Fig. 1. Course of PTSD over time: Point estimates and confidence intervals for proportion of sample meeting criteria for current PTSD (*DSM-IV*) at each time point. The top panel shows estimates for the combined sample ($n = 561$), the middle panel shows estimates for Tezuitlán ($n = 176$), and the bottom panel shows estimates for Villahermosa ($n = 385$).

Table 2. Mean Number of PTSD Criterion Symptoms by City and Time (Unadjusted)

Variable	M (SD)			
	Wave 1	Wave 2	Wave 3	Wave 4
Total symptoms (BCD)				
Tezuitlán	11.2 (3.8)	8.0 (4.2)	6.5 (4.1)	6.3 (4.1)
Villahermosa	6.7 (4.7)	5.5 (4.0)	4.3 (3.7)	4.4 (3.7)
Intrusion (B)				
Tezuitlán	3.6 (1.3)	2.5 (1.6)	1.8 (1.6)	1.9 (1.6)
Villahermosa	2.4 (1.7)	1.9 (1.6)	1.2 (1.4)	1.3 (1.4)
Avoidance/numbing (C)				
Tezuitlán	3.8 (1.9)	2.8 (1.9)	2.4 (1.9)	2.1 (1.8)
Villahermosa	2.1 (1.9)	1.7 (1.8)	1.4 (1.6)	1.5 (1.7)
Arousal (D)				
Tezuitlán	3.9 (1.3)	2.8 (1.5)	2.3 (1.4)	2.4 (1.4)
Villahermosa	2.3 (1.7)	2.0 (1.5)	1.7 (1.5)	1.7 (1.4)
Functional impairment (F)				
Tezuitlán	1.7 (1.0)	1.0 (1.1)	0.6 (1.0)	0.5 (0.9)
Villahermosa	1.1 (1.1)	0.6 (1.0)	0.3 (0.7)	0.3 (0.7)

at both Waves 1 and 2, the average number of symptoms decreased over that interval from 14 to 12, $t(54) = 3.85$, $p < .001$, even though their score (1) on the dichotomous variable, PTSD, did not change. Similarly, among respondents who met criteria for PTSD at neither Wave 1 nor 2, the average number of symptoms decreased over that interval from 6 to 4, $t(379) = 6.38$, $p < .001$, even though their score (0) on the dichotomous variable, PTSD, did not change. Thus change in the prevalence of diagnoses does not tell the whole story of postdisaster recovery.

Mean data (average number of criterion symptoms at each wave) are presented in Table 2. This table shows, for example, that residents of Tezuitlán averaged approximately 11 symptoms altogether (from a set of 17 possible symptoms) at Wave 1. They averaged eight symptoms at Wave 2 and closer to six at Waves 3 and 4. In contrast, residents of Villahermosa averaged seven symptoms at Wave 1, six symptoms at Wave 2, and four symptoms at Waves 3 and 4.

To conduct the trend analysis, we used repeated-measures MANCOVA, with city as the between-group variable, time (Waves 1–4) as the within-subjects variable, and education as a covariate. Our hypotheses indicated that we should find (1) a significant main effect of city (Tezuitlán higher, averaged over time); (2) a significant linear trend for time (symptoms higher in the earlier waves, averaged across cities); (3) a significant quadratic trend for time (symptoms decline initially, then stabilize, averaged across cities); and (4) a significant interaction between city and time, specifically for the linear trend (the difference between cities more pronounced in the earlier waves than in the later waves). After conducting this analysis for the total count of symptoms, we repeated the analysis for the clusters of intrusion (B, range

0–5), avoidance/numbing (C, range 0–7), and arousal (D, range 0–5) symptoms and for the number of indicators of impaired functioning (F, range 0–3) affirmed. Means for these measures are also provided in Table 2.

Our hypotheses were supported in the primary analysis conducted for the total symptom count (B–D) over time. First, it should be noted that the covariate, education, showed a strong effect on symptoms, $F(1, 557) = 51.43$, $p < .001$, but did not interact with time, $F(3, 557) = 1.08$. With the influence of education on symptoms controlled, there was a main effect of city, $F(1, 557) = 52.92$, $p < .001$. On average, across waves, Tezuitlán was higher in symptoms than Villahermosa (see Table 2). There was also a main effect of time, $F(3, 557) = 66.55$, $p < .001$, indicating that, averaged across cities, symptom levels changed over the course of the study. Tests for the linear (overall declining) trend, $F(1, 557) = 135.50$, $p < .001$, and the quadratic trend (decline followed by stabilization), $F(1, 557) = 30.69$, $p < .001$, were both statistically significant. There was, finally, a significant interaction between city and time, $F(3, 557) = 15.87$, $p < .001$. The interaction was strong for the linear trend, $F(1, 557) = 29.42$, $p < .001$, because the improvement was more pronounced in Tezuitlán, making participants in the two cities more alike in later waves than in earlier waves. We did not anticipate the interaction between city and the quadratic trend, $F(1, 557) = 8.79$, $p < .001$. The turn in the data was sharper for Villahermosa than for Tezuitlán. Nonethess, as predicted, both cities showed a similar tendency to improve, then stabilize, as time passed. Findings for the specific symptom clusters largely echoed the findings for the total symptom count, with the lone exception being that no interaction between city and the quadratic trend emerged for avoidance/numbing symptoms.

The trends over time in functional impairment were similar as well. Although there was no effect of education, $F(1, 557) = 3.39$, effects did emerge for both city, $F(1, 557) = 27.24$, $p < .001$, and time, $F(3, 557) = 48.83$, $p < .001$. On average, participants in Tezuitlán exhibited more impaired functioning than did participants in Villahermosa. The effect of time was again predominantly linear, $F(1, 557) = 111.50$, $p < .001$, although a quadratic trend was also evident, $F(1, 557) = 25.60$, $p < .001$. The form of the effect was consistent with the prediction that an initial decline in symptoms would be followed by stabilization. City again interacted with time, $F(3, 557) = 5.18$, $p < .001$, but the interaction was confined to the linear trend, $F(1, 557) = 12.22$, $p < .001$. Once again, this was because the decline was steeper in Tezuitlán so that differences between cities became less pronounced as time passed.

Comorbidity With MDD Over Time

The relative frequencies of MDD were 9.1% ($SE = 1.2$) at Wave 1, 7.9% ($SE = 1.1$) at Wave 2, 6.8% ($SE = 1.1$) at Wave 3, and 5.9% ($SE = 1.0$) at Wave 4. For a sample of this size, these values do not demonstrate a declining trend because confidence intervals overlap, e.g., the lower bound of the 95% confidence interval at Wave 1 (6.6%) is lower that the upper bound of the interval at Wave 4 (7.9%).

As expected, there was a substantial degree of comorbidity between PTSD and MDD. Proportions of PTSD cases meeting criteria for MDD did not differ across cities, $\chi^2(1, N=135) < 1$. Proportions of PTSD cases with MDD did not vary over time: MDD criteria were met by 20.1% ($SE = 3.5$) of 134 PTSD cases at Wave 1, 27.7% ($SE = 4.5$) of 101 PTSD cases at Wave 2, 21.7% ($SE = 5.3$) of 60 cases at Wave 3; and 24.2% ($SE = 5.3$) of 62 cases at Wave 4. Across time and city, the average prevalence of MDD among PTSD cases was 23.4%, whereas the average prevalence of MDD among PTSD noncases was 4.4%, roughly a 5:1 ratio.

Discussion

Latin America is an important context for disaster research because disasters are prevalent in this area of the world, their impact is often quite severe, studies of them are proportionately few, and those studies that have been conducted are typically limited by cross-sectional designs and convenience samples. Recognizing the shortcomings of much previous research, we attempted to conduct as methodologically rigorous a study as possible in Mexico. Although not without its limitations, our study has three major strengths. Probability sampling strategies coupled with high response and retention rates yielded samples that were representative of two cities that experienced Mexico's 1999 flood in two distinct ways. Second, the CIDI, which is widely regarded as the best option available today for international psychiatric epidemiology, provided sound data on *DSM-IV* criteria for PTSD and MDD. Third, a longitudinal panel design, in which over 500 adults were assessed four times at 6 month intervals, allowed a rare examination of the course of postdisaster PTSD symptoms and other outcomes over time.

The effects of this disaster were severe. Six months postevent, the prevalence of current disaster-specific PTSD was strikingly high. One in four adults with PTSD also suffered from MDD, and 28% of the combined sample exhibited one disorder or, the other or both. High levels of posttraumatic stress were also reported in two

previous studies of disasters in Mexico, specifically the 1985 Mexico City earthquake (32% PTSD, 13% MDD; de la Fuente, 1990) and Hurricane Paulina (29% PTSD; Norris, Perilla, Ibañez, & Murphy, 2001). PTSD, MDD, or both have been prevalent after other Latin American disasters as well (e.g., Caldera et al., 2001; Lima et al., 1991). Comparative studies are few but two prior studies (Durkin, 1993; Norris, Perilla, Ibañez, et al., 2001) found comparable disasters in the United States and Latin America to have more severe effects in Latin America. Moreover, US studies have sometimes found Latinos to be at higher risk for postdisaster PTSD than other survivors (Galea et al., 2002; Perilla, Norris, & Lavizzo, 2002). Such effects raise the possibility that Latin Americans may be at higher risk than other Americans are for PTSD and related disorders, but much more research is required before such conclusions could be reached with certainty.

More generally, these findings from other events suggest that the present results are not unique to the 1999 disaster, or to the two settings studied, and serve as a reminder that natural, as well as human-caused, disasters have the capacity to engender severe psychological trauma in exposed populations. Natural disasters are highly variable in form and severity, and so are their effects. The high rates of PTSD documented here should not be altogether surprising because high proportions of participants were displaced, bereaved, injured, or endangered by the floods and mudslides of 1999. For anticipating the psychological toll of disasters, the designation of human-versus-natural causality may therefore be less informative than dimensional classifications that focus on the severity of losses and trauma experienced in relation to the resources available in the stricken community (e.g., Bolin, 1985; Green, 1982).

The present study also demonstrated that the same event may have very different consequences when communities experience the event in different ways. In Tezuitlán, the prevalence of PTSD at 6 months postevent (46%) was over three times higher than the prevalence observed in Villahermosa (14%), which was itself far from trivial. Current MDD was also higher in Tezuitlán (15%) than in Villahermosa (7%). When PTSD and MDD were considered, half (51%) of the Tezuitlán sample suffered from a current major mental disorder, compared to 18% of the Villahermosa sample. A number of factors probably contributed to this, especially the horror, bereavement, and displacement experienced by survivors in Tezuitlán. The present highly quantitative examination did not capture well the research team's observations of the challenges posed by the decision to relocate survivors to a new settlement that appeared isolated from the city as a whole and was almost completely lacking in infrastructure (including

water, electricity, and roads) or community identity other than residents' shared traumatic loss. Imagine how difficult it must be to build community when nearly half of the builders are currently suffering from full PTSD and almost all are distressed to some degree. Future research needs to capture these community-level experiences and challenges more richly and completely. Moreover, although education alone did not explain the city effects, factors not examined in the present analysis, such as psychological, social, and material resources, may have also played a role, and these factors will be important to consider in future analyses. These basic descriptive findings provide a framework for examining and interpreting other effects in this regard.

Consistent with most previous longitudinal studies of disasters, the prevalence of current PTSD declined over time. By the end of the study, rates of current PTSD had declined from 14 to 8% in Villahermosa and from 46 to 19% in Tezuitlán. Even at 2 years postevent, however, the prevalence of PTSD remained high enough to be of public health concern and much higher than the base-rate of current PTSD in Mexico (2%). Analyses of mean data for counts of PTSD symptoms indicated that the natural course of PTSD involves both linear and quadratic trends. That is, symptoms first decreased but subsequently stabilized. Other investigators who have collected postdisaster data on three or more occasions have found similar nonlinear patterns or trends (e.g., Bromet et al., 1990; Carr et al., 1997; McFarlane, 1989). Although this pattern was expected on the basis of past research, it is noteworthy that the turn in the data did not occur until 18-months postevent, later than we had anticipated. The degree of recovery occurring after the 1-year point was substantial (see Fig. 1), indicating that distress may be quite prolonged in the aftermath of major disasters. These data also suggest that if recovery has not occurred within 18 months or so, it is unlikely to happen at all. In this way, our findings are consistent with larger epidemiologic studies of PTSD, which have suggested that PTSD takes a chronic course in approximately one third of those who develop the condition (Breslau et al., 1998; Breslau, Davis, Andreski, & Peterson, 1991; Kessler, Sonnega, Bromet, Hughes, & Nelson, 1995).

From a policy perspective, our results provide compelling evidence that the international health community needs to anticipate and prepare for epidemics of PTSD, and to a lesser extent MDD, when disasters strike developing countries, especially when the events are associated with mass casualties and a high degree of community destruction. Certainly, these findings point to a need to develop both early and ongoing interventions that provide mental health care to disaster victims in a way that is

culturally appropriate and feasible for places, like Tezuitlán, that have few mental health professionals to draw upon. Somasundaram, Norris, Asukai, and Murthy (2003) presented numerous recommendations for community, family, and individual interventions that would be appropriate in the context of most developing countries. No one set of recommendations will apply to all communities cross-culturally. It is important that the activities match the cultural context and needs of the group. The best way to assure this is to involve the community in evaluating its own needs and determining which actions are most suitable.

Acknowledgments

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